ENGINEER- Vol. XXXXI, No. 05, pp. 95-104, 2008

Potential of Urban Land Management using Geographic Information Systems

A Study of Thimbirigasyaya Ward Colombo

H. H. Leelananda, N. T. S. Wijesekera, and T. A. Peiris

Abstract : With the population growth and associated high levels of urbanization, sustainable urban development has become a critical issue in Sri Lanka. A land information management tool was developed for the Thimbirigasyaya ward of the Colombo Municipal Council (CMC) Sri Lanka using a Geographic Information System incorporating multi layer analysis. The layers incorporated contained the spatial distribution of land parcels, buildings along with zoning details established by the Urban Development Authority. This paper presents the potential of the GIS based system for rational land parcel management by considering various scenario with respect to the presently available zoning, zoning regulations combining with land parcel and building information. Potential use of GIS for Land Management in the Colombo city including real estate development and also drainage improvement is discussed. Proposals are made for the decision makers to take into consideration when executing responsible action. In the analysis it was identified that the Primary Residential Zone meant for high rises is mostly of low rises and there is a significant potential for development. Overlay operations enable a manager to identify amalgamation options to suit the land development policy of the UDA. The tool also demonstrates the identification of old buildings that may be worthy of demolition to make room for planned development. The tool also enabled the identification of main user types within identified zones so that a decision maker could propose better economic use of land through means of relocation. This casestudy presents not only the importance of land clearance management but also the vast potential for policy making and rational management.

1. Introduction

Almost all major urban centers in Sri Lanka face a population explosion and as a result, cities constantly change in size and scale, type of housing, land-use patterns, street layout and architectural style. These features have a significant influence on the appearance of the city, its character and identity. Colombo the commercial Capital of Sri Lanka has been experiencing the same and as a result the land management in the Colombo Municipal area has been a very challenging task.

Physical plans had been prepared for Colombo since colonial times. The first attempt had been made by Sir Patrick Geddes in 1921. The main concept of the plan had been to make the City of Colombo "The Garden City of the East". In 1948 Patrick Abercrombie had developed a plan which was approved by the Central Planning Commission in March 1949. This plan had focused on the City of Colombo and the surrounding region covering nearly 220 sq. miles. Decentralization of activities was one of the main objectives of this plan. In 1978 the Master Plan project for the Colombo Metropolitan Region prepared two interrelated documents, namely the Colombo Metropolitan Regional Structure Plan and the Colombo Urban Area Plan Establishment of the Urban Development Authority (UDA) as a planning organization was also a direct outcome of the Colombo Master Plan. Colombo population on average consists of 41% Sinhalese, 29% Tamil 24% Moor and Others(City 2008). The City of Colombo Development Plan was prepared and gazetted by the UDA in 1985 and this enabled the UDA to carry out zoning and building regulations.

The city of Colombo development plan which was revised and gazetted by the UDA in 1999

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(UDA 1999) indicates a population of 638,000 in the Colombo Municipal Council (CMC) for the year 1994 where as according to a census figure of 2001, the population in CMC has reportedly risen to 647,100 (City 2008). The present average population density is 174 persons per ha.

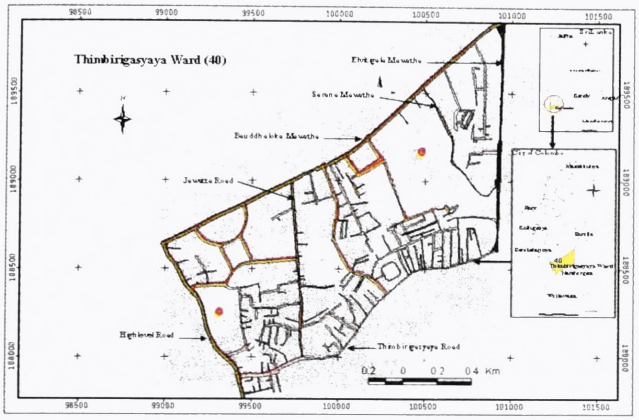
In Colombo Sri Lanka, Land information management becomes an integral part of urban development and urban land management because of the pressure on land exerted by the increasing population and associated activities. UDA (1999) indicates many land issues as constraints in the core area of Colombo. A major shortcoming that had been cited is the inadequate coordination of the need or urban land for other than residential activities and uses such as commercial, business, banking & finance, transportation and storage. It has also indicated that the declaration of the area north of Colombo as mixed and primary residential zone had limited many development activities in the area. The report continues to mention many issues related to the land ownership/ tenure, encumbrances of buildable land, issues related to horizontal expansion, unplanned distribution of residential, commercial and other activities. There is a great potential to manage land and its information using geographic information systems and many examples can be seen in literature (Leelananda, Wijesekara and Peiris 2005). However the lack of a well structured GIS based land information system for urban areas of Sri Lanka has been noted and this could be a reason for many difficulties that arise in urban land management. It is therefore very important to develop a structured and an accurate land information GIS and demonstrate the potential uses so that decision makers of Sri Lanka could be better convinced to commence on the development of an appropriate system. A system for land development and approval management using GIS was completed (Leelananda, Wijesekera and Peiris 2005) and it was indicated that using the GIS with appropriate changes would reduce the time taken for the process of land clearance to five days from the presently estimated duration of 40 days. Geographic Information Systems are new to most of the people and they deal with maps which are usually not treated as information friendly material by many persons (Albert and Yeung 2005). As GIS and its capabilities are not known for many, even though the databases are prepared and verified by resource persons, the lack of application examples as to how maps and databases could be used interactively, has been the main reason for the top management to delay the effective use of this vastly potential tool. Therefore it is very important to present several example applications of GIS data and outputs so that the managerial and decision making personnel could base such examples to widen their leadership and managerial skills to carryout activities in a very effective manner. This paper presents the potential use of an already developed and accurately checked GIS database for the presentation of examples of applications that could be used for the effective planning and management of urban land.

2.0 Objective

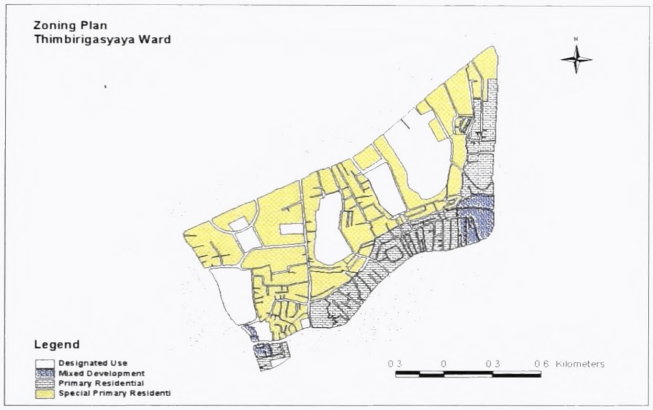
The main objective of the work is to analyze the present situation of the land resources in a selected case-study area with respect to the development plans and to assess suitable land management options so that the potential and the benefits of using a GIS database for land resource management is suitably demonstrated.

3.0 Study Area

Sri Lanka has an approximate land area of 65,610 sq. km. Out of the 9 provinces in Sri Lanka the Western province is treated as the most important province since the administrative capital Sri Jayawardenapura and the commercial capital Colombo are both located in this province. The city of Colombo has been named as the most complex urban center of the Western Region. The CMC covers an area of approximately 3729 ha and consists of 47 municipal wards. The present work opted to select the study area as the Thimbirigasyaya municipal ward (Ward No 40) covering 161 ha (Map 1) and having a population of about 13,800 at a density of 86 persons per ha. It was identified that the Thimbirigasyaya ward has approximately 1404 land parcels, possess the maximum density of vacant lots, the minimum plot coverage, minimum floor area ratio, minimum density of slums & shanty and minimum population density. The comparison of these parameters indicated that the Thimbirigasyaya ward had the maximum development potential and as a result an



Map 1 : Study Area Location



Map 2 : The Designated Landuse Zones in the Study Area

important area in terms of land development. Thimbirigasyaya Ward consists mainly of four land use zones (Map 2) and each has different regulations in order to maintain the developments. The database preparation, selection of study area have been justified in Leelananda, Wijesekara and Peiris (2005)

4.0 Literature Review

4.1. GIS for Land Information Management

In a city the most important characteristic is the availability of a development plan that has been formulated with proper authority. The Colombo city development plan has been in place for some time and it is therefore important to identify the present scenario with the development plan. Though the importance of having a development plan and adhering to the guidelines has been identified by many literature, some have actually been critical about some plans which do not provide sufficient considerations to the conservation aspects. The development of multi-storey buildings in areas mainly with two storey buildings have been indicated as a threat to street and square silhouette and organic texture which in turn would lead to incompatibilities with the principles of conservation (Ulu, Aksoylu and Cabuk (2005)). Urban land management improvement had been recognized as an important element in Sri Lanka. Mendis (1998) indicates the attempts made to develop a Geographic Management Information System (GMIS) to overcome the problems with regards to effective land management and also to carryout systematic monitoring of the changes to land boundaries. It also indicates that Tax mapping has not been practiced in any of the urban local authorities in Sri Lanka, though the urban planners have been using land value information for the preparation of urban development plans.

GIS enables the planners to ensure the environmental balance by identifying the presence of associated components in a given urban area. Mapping of environmental components along with property details also enables the formulation of policy and action plans to ensure intra-city environmental stability. Therefore, environmental mapping for integrated urban infrastructure planning and management plays a very important role in urban area governance (Mehta, Ragupathi, and Sharma 1996).

In countries such as Singapore where land is a critically limited resource, it is very important to strike an optimal balance of land use considering the growing requirements to accommodate industries with an appropriate value creation for the real estates (Ming and Hin 2006). In this a Geographic Information System incorporating a real estate valuation model has shown effective in the analysis of the spatial distribution of urban industrial real estate asset values. This study which has considered the industrial estates individually has divided each estate to specific spatial units and used ArcView software to carryout the spatial distribution analysis. The relevant datasets had been subjected to non-parametric statistical tests enabling the value turnover time to be modelled over an identified period.

A system for land development approval management using Geographic Information Systems (Leelananda, Wijesekara and Peiris 2005), for the Thimbirigasyaya ward emphasizes

Table 1: Selected Land Use Development Zones

Item	Zone Description	Important considerations from explanatory notes on permissible activities as in the Colombo City Development Plan (UDA(1999))
1	Special Primary Residential Zone (SPRZ)	This zone is mainly for residential development and having housing units ranging from a single floor to a maximum of 3 floors including the ground floor (Vol.1, pp 49).
2	Primary Residential Zone (PRZ)	For plot sizes less than 10 perch in extent, the uses and heights of buildings permitted are only those permitted in special primary residential zone. There are 10 activities for extents more than 10 perch (Vol. 1, pp 51).
3	Mixed Development Zone (MDZ)	The mixed development zone is intended to serve as a transitional area between the primary residential and commercial zones (Vol. 1, pp 51).

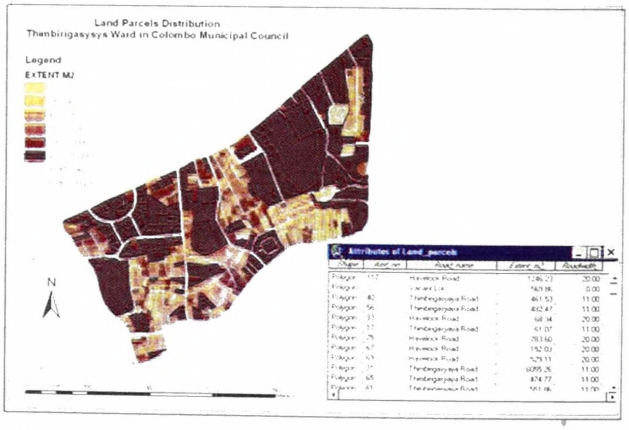
the extremely important aspects of Land GIS development. This work presents the factors that have to be taken into consideration with regards to the accuracy, structure, layers etc. The work directly deals with the data of the Colombo city and therefore, provides the land managers with detailed information pertaining to GIS model development for land resource planning. This work also cites a number of important literature on the model development, planning etc.

4.2. Land Zoning System

The plan for City of Colombo had been prepared with the incorporation of land use zoning. The zoning regulations (UDA 1999) has identified eight distinct zones for Colombo city and they are 1) Special Primary Residential 2) Primary Residential 3) Commercial 4) Mixed Development 5) Concentrated Development 6) Port Related Activity 7) Recreational Zone and 8) Environmental Conservation Zone. The study area consists of several designated use area and three identified zones namely the Mixed Development, Primary Residential and Special Primary Residential. As such, the present work analyses land data in connection with these three zones. Details of the considered zones are in Table 1.

5.0 Methodology

The Land Parcel information available at the assessment department of the CMC were scanned and taken for database preparation. These spatial data were georeferenced and a mosaic was constructed using 24 images, which were then scanned in TIFF image format. Screen digitizing and attribute data table entries were done to develop the GIS. Field inspections were carried out to check the accuracy of map and attribute data. Accuracy of digital database was checked for errors during photocopying and scanning. The errors were checked in comparison with the present regulations and also comparisons were done with field measurements (Leelananda, Wijesekera and Peiris 2005). GIS database was developed by incorporating properly developed digital map layers consisting of data pertaining to Assessment Number, Access Road Name, Parcel Extent, Zone Name, Minimum Lot Sizes, Minimum no of Floors, Maximum no of Floors, Usage, Building Heights, Age of Building, Number of Floors, Tenancy Types, Ground Floor Area, Total Floor Area, Road Name, Road Type, Road Width, and Road Length. The ArcView GIS software was used for the spatial database development. Attribute accuracy was tested for the accuracy of map and dataset linkage corresponding to a specific spatial entity and also for the accuracy of data entry. Data entry accuracy was tested with random sample data. GIS database was founded on three map layers and corresponding attribute tables. The three map layers are, 1) Land parcel layer, 2) Building Layer, and UDA Zoning Layer. The Map 3 shows the Land parcel map and its



Map 3: A Typical Data Layer in the Database - Land Parcel Layer and Attribute Table

Table 2: Building Type, Floor Disribution Plot Area Coverage in Thimbirigasyaya Ward

Zone	Building Classificat	Floor Range	No. of Buil	Plot area n	Ground Floor Ar	Ground FA/Plot Area%
SPRZ	Low Rise	1 - 3 Floors	768	1,186,691	309,698	26.0976
	Intermediate Rise	4 - 8 Floors	5	11,903	5,184	43.5508
	Middle Rise	9 - 12 Floor	0	0	0	
	High Rise	13 & above	0	0	0	
	Vacant			27,280		
		Total	**773**	**1,225,875**	**314,882**	**25.6863**
PRZ	Low Rise	1 - 3 Floors	410	312,535	102,133	32.6789
	Intermediate Rise	4 - 8 Floors	1	381	143	37.5348
	Middle Rise	9 - 12 Floor	0	0	0	
	High Rise	13 & above	0	0	0	
	Vacant			20528		
		Total	**411**	**333,444**	**102,276**	**30.6726**
MDZ	Low Rise	1 - 3 Floors	77	67,678	21,658	32.0014
	Intermediate Rise	4 - 8 Floors	0	0	0	
	Middle Rise	9 - 12 Floor	0	0	0	
	High Rise	13 & above	0	0	0	
	Vacant			5,286		
		Total	**77**	**72,964**	**21,658**	**29.6830**

attribute table as an example of the format of GIS database. Checking of data accuracy was important because any substantial differences in the stored and actual data would not be acceptable to the authorities and also would not receive public confidence. This was very important in case of the study area where the land prices were already high, fetching over Rs. 1,000,000.00 per perch (25 m2) and indicating an approximately 67% rate of increase during 2005-6 period (Kapruka 2008). Considering the requirements of the UDA (1999) and high value of lands, the errors when preparing the database were assessed and were found very low (Leelananda, Wijesekera and Peiris 2005).

Data layers were geoprocessed to capture the land parcels, building, uses etc., within each land use zone as gazetted (Gazette 1999). Existing scenario of buildings, area use, free spaces, etc were summarized to summarize a situation analysis. These results were critically evaluated to identify developments that may be effected in future.

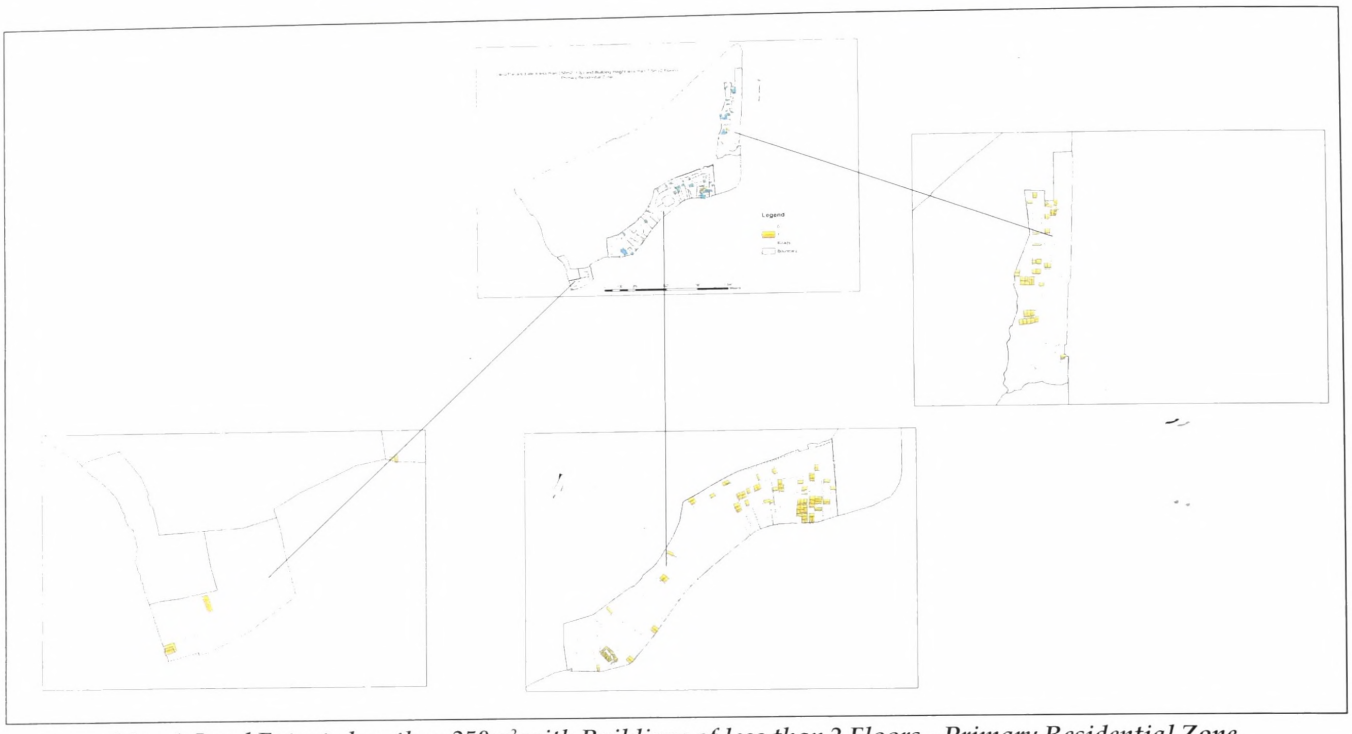
6.0 Computations and Discussion

6.1. Primary Residential Zone

Primary Residential Zone (PRZ) is mainly for residential development and this area is permitted to have housing units up to a maximum of 10 floors including the ground floor and commercial establishments are limited to small extents. The total PRZ area that falls within the study area is 33.3 ha, which is 20.4% of the total area of the ward. Building distribution and the plot size, building occupation, and the floor area distribution along with the UDA classification is shown in the Table 2

The present status of the zone indicates that the existing buildings are mainly up to three floors and consisting of 411 units (99.8%). Also the present usage distribution indicates that the plot area used for other than residential buildings are approximately 196,000 m2 which is 58.8% of the zone and the vacant plots in the area is about 20,500m2 (6%) of the Zone. The Residential buildings which are 60.58% of the total in the PRZ, have an average land coverage percentage of 37.27% in their present allotments. The age of the buildings show that 60.6% are less than 20 years old. 37.7 % of the total are older than 20 years but newer than 40 years. An approximately 6.6% of the land in this zone consists of plots having an area less than 250 m2 (10 perch) where the total number of plots are 149 with 139 building units are on these plots. Overlay of land parcels with buildings, indicated an existence of 57 land parcels having buildings older than 20 years on land parcels less than 250 m^2 (10p).

Building regulations do not permit lands with less than 250 m2 of area to be sub divided (UDA 1999). The spatial distribution of these land parcels indicate that there are over 100 adjacent land parcels that can be merged with one another to fall into the group which can be



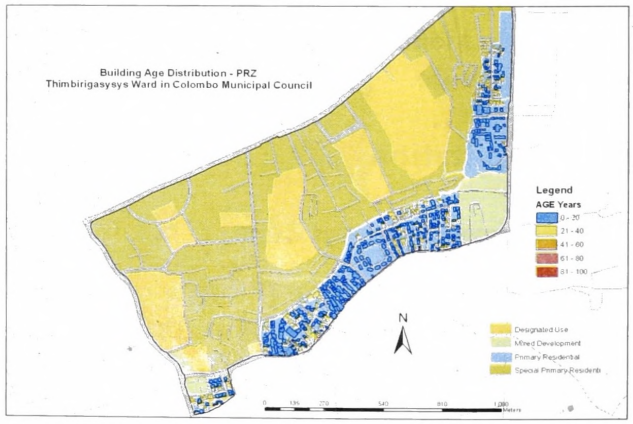
Map 4: Land Extents less than 250m² with Buildings of less than 2 Floors - Primary Residential Zone

developed as high-rises up to 10 floor. The land extents with an area of less than 250 m2 and having less than 2 floors (Map 4) can be identified easily with the spatial statistics and building parameters so that development alternatives can be identified.

In the Primary Residential Zone the number of houses more than 20 years old counts to 163 which is approximately 40% (Table 3). Out of this there are not any preserved units as identified by the CMC. GIS database indicated that 57 non preserved number of houses greater than 20 years old are on land plots less than 10 perch. Since there are many houses greater than 20years old, in adjacent land allotments, it is possible to consider the number of floors, present occupation etc., and then amalgamate for real estate development to achieve the most benefits by constructing residential units up to 10 floors, as permitted in the UDA regulations. The Map 5 indicates the spatial distribution of housing units in the PRZ classified according to their age.

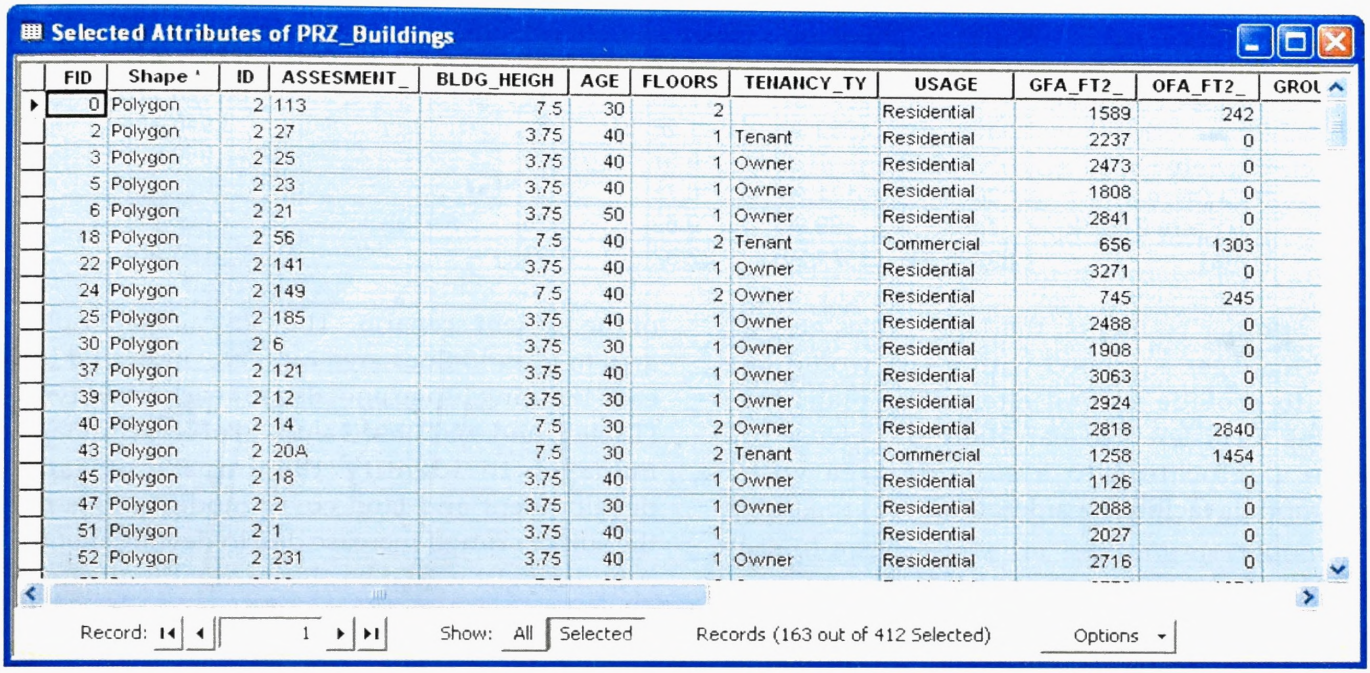
6.2. Special Primary Residential Zone

Special Primary Residential Zone (SPRZ) is mainly for residential developments and is proposed to have housing units ranging from a single floor to a maximum of 3 floors including the ground floor. The regulations clearly indicate that non-residential activities are discouraged in this zone. Only three activities, i) Petrol filling stations, ii) Groceries not exceeding 50 sqm and iii) Places of public worship can be continued until such time they are relocated to a suitable place-Regulations specifically indicate that architectural character of the buildings of this area should be residential and should follow the traditional architecture of the original building that existed on the site. Table 4 shows the usage of buildings in this area and the spatial distribution is shown in Map 6. According to the available data, all residential units in the Zone are less than three stories except for one commercial building with four stories. The average plot coverage by the buildings is 26.27% and residential plot



Map 5: Spatial Distribution of Housing Units in the PRZ according to the Age of Building

Table 3 : Buildings more than 20 years Old



Selected Attributes of PRZ_Buildings

FID	Shape *	ID	ASSESMENT_	BLDG_HEIGH	AGE	FLOORS	TENANCY_TY	USAGE	GFA_FT2_	OFA_FT2_	GROU
0	Polygon	2	113	7.5	30	2		Residential	1589	242	
2	Polygon	2	27	3.75	40	1	Tenant	Residential	2237	0	
3	Polygon	2	25	3.75	40	1	Owner	Residential	2473	0	
5	Polygon	2	23	3.75	40	1	Owner	Residential	1808	0	
6	Polygon	2	21	3.75	50	1	Owner	Residential	2841	0	
18	Polygon	2	56	7.5	40	2	Tenant	Commercial	656	1303	
22	Polygon	2	141	3.75	40	1	Owner	Residential	3271	0	
24	Polygon	2	149	7.5	40	2	Owner	Residential	745	245	
25	Polygon	2	185	3.75	40	1	Owner	Residential	2488	0	
30	Polygon	2	6	3.75	30	1	Owner	Residential	1908	0	
37	Polygon	2	121	3.75	40	1	Owner	Residential	3063	0	
39	Polygon	2	12	3.75	30	1	Owner	Residential	2924	0	
40	Polygon	2	14	7.5	30	2	Owner	Residential	2818	2840	
43	Polygon	2	20A	7.5	30	2	Tenant	Commercial	1258	1454	
45	Polygon	2	18	3.75	40	1	Owner	Residential	1126	0	
47	Polygon	2	2	3.75	30	1	Owner	Residential	2088	0	
51	Polygon	2	1	3.75	40	1		Residential	2027	0	
52	Polygon	2	231	3.75	40	1	Owner	Residential	2716	0	

Record: 1 Show: All Selected Records (163 out of 412 Selected) Options

Table 4 : Buildings Usage of the Thimbirigasyaya Ward

Zone	Building Usage	No of Plots	No. of Grou	Plot Area	Ground FA	Ground FA/Plot Area%
SPRZ	Residential	470	470	360,778	122,842	34.0492
	Defence	6	6	84,598	15,741	18.6069
	Commercial	51	51	80,741	19,392	24.0175
	Office & School	24	24	112,475	37,491	33.3327
	Non-residential	2	2	10,182	2,244	22.0383
	Unavailable Usage	220	220	549,820	117,172	21.3110
	Vacant Plots	61		27,280		
	Total	**834**	**773**	**1,225,875**	**314,882**	**25.6863**
PRZ	Residential	249	249	116,746	43,513	37.2716
	Commercial	20	20	7,970	3,873	48.5934
	Office	2	2	743	313	42.0993
	Unavailable Usage	140	140	187,457	54,577	29.1144
	Vacant Plots	56		20,528		
	Total	**467**	**411**	**333,444**	**102,276**	**30.6726**
MDZ	Residential	37	37	20,400	7,319	35.8767
	Commercial	32	32	3,275	1,772	54.0996
	Office	1	1	343	202	58.9334
	Bank	1	1	784	157	20.0357
	Unavailable Usage	6	6	42,876	12208	28.4728
	Vacant Plots	26		5,286		
	Total	**103**	**77**	**72,964**	**21,658**	**20.0357**

coverage is 34.05%. (Once the individual plot coverage is computed then this has to be addressed with the frequency distribution and mean, standard deviation)

The distribution of land in the SPRZ indicated that an approximately 9 hectares have been allocated to the Defense Ministry (Map 7, Table 5). The Bandaranaike Memorial International Conference Hall (BMICH) (area 121,058 m2), The irrigation Department (6885 m2), Sathosa of Trade Ministry (4262 m2) are some of the larger public offices which are permitted under the category described as Public Offices, Institutions, Bank offices, with an extent exceeding 1000 sqm. (UDA 1999). The occupation of land in the residential area by different agencies can be effectively analyzed along with the spatial distribution details of the concerned units of interest provided by the GIS. The defense occupation of land in this prime residential zone of Colombo is approximately 9 hectares with a total value of about Rs. 81 billion. Considering the security of the defense persons, defense security provision costs, risk of residing and moving from one place to another,

Table 5: Defense Uses located in Special Primary Residential Zone and Land Values

Defence Use	Sq. M.	Purchase	Acres	Hectares	Land Value (m)	Amount (m)
Army Camp	4714.51	188.58	1.18	0.47	20	3,771.61
Police Department	71932.79	2877.31	17.98	7.19	23	66,178.17
Police Office	5055.77	202.23	1.26	0.51	18	3,640.15
SL Police	2032.1	81.28	0.51	0.20	24	1,950.82
CID Office	3048.36	121.93	0.76	0.30	24	2,926.43
Air Focre Barack	2497.41	99.90	0.62	0.25	30	2,996.89
Total	**89280.94**	**3571.24**	**22.32**	**8.93**		**81,464.06**

risk of other residents, the land prices etc., a land manager equipped with a GIS would be able to provide several alternative plans for having a clustered demarcation for defense or even a relocation to a suitable area with appropriate facility consideration.

6.3.Mixed Development Zone (MDZ)

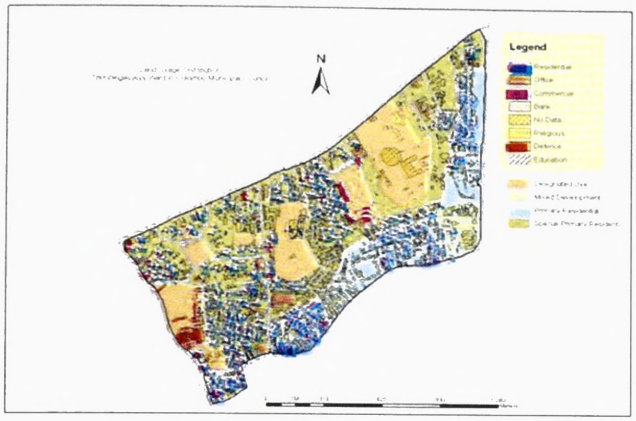
Mixed Development Zone is intended to serve as a transition area between the Primary Residential and Commercial Zones. This can be clearly seen from the building usage details in Table 4. Commercial and Residential Buildings numbers are 35% and 32% respectively indicating a balance in the ratio of number of buildings. However a plot area distribution shows that the same percentages are approximately 28% and 5% indicating a clustering of commercial establishments. The data base had no information pertaining to 59% of the MDZ and these should be included to enable land managers to arrive at rational management decisions according to the zoning plans of the Government.

6.4. Geographic Information

The details of the Thimbirigasyaya Ward pertaining to the land parcel size and the plot numbers are given in the Table 5. This kind of summary statistics enabled in the GIS permits a manager to look at the spatial distribution of land parcels of interest or the buildings of interest to perform easy analysis either using tabular data, visual interactions or with overlay operations. It is noteworthy (Table 2) that the residential areas are mostly with low rise buildings consisting of floor area between 1-3 floors. Though the primary residential area is open for development of units upto 10 floors, the recognition of the lack of such units would enable a decision maker to either review zoning or promote development actions based on an accepted policy arrived at after a careful review of the present scenario. The GIS calculated plot area to ground floor area ratio are indicated for each building usage and also for each build type (Table 2 and 4). These values enable a drainage manager to identify the impact of land development and land cover modifications on the surface runoff increase due to developments. A hydrologist would be able to identify the flow quantities and the flow directions thereby suitable planning can be achieved. The total plot area and the ground floor areas calculated from the GIS (Table 3) shows that the total residential plot area coverage in the ward is 497,924 m2 and the ground floor area is 173,674 m2. The same for commercial usage indicates values of 92086 m2 and 25037 m2 respectively for plot area and ground floor area. Assuming that the ground floor area is the total paved area in a plot which could be considered as impervious, and that the reset of the area is soil which could soak 50% of the water it receives from rain, then a manager could identify the quantity of rain water that would reach the drainage network in the area. It is often seen that most land owners pave or build on their additional land extents which were left as balance area. Though this is quite understandable with the desire to build or to have all weather paved access to the lands which are exponentially increasing in value, an urban area development manager needs to look

Table 6: Plot Area Coverage and the Number of Building Units in Each Development Zone

Plot Area sq meter	Number of Units in Zone		
	SPRZ	PRZ	MDZ
0-250	216	149	67
250-400	124	99	16
400-750	248	156	9
750-1000	60	22	4
1000-2000	84	24	3
2000-122000	102	17	4
Total	834	467	103



Map 6: Building Usage in the Thimbirigasyaya Ward, Colombo.

Map 7: Defense Uses located within the Special Primary Residential Zone

at the repercussions especially with respect to localized flooding of urban area. GIS enables the computation of increased water load to the drainages and also to which particular drainage in case a change of land cover takes place from non paved to paved. The study looked at the potential change of water quantity with respect to a change of paved area with respect to commercial and residential area only. A trial scenario having a change of 50% of the remaining area of a residential plot as paved, and a paving of 100% of the balance area in case of a commercial building was considered to identify the probable increase of surface runoff. An approximate runoff coefficient of 0.55 for gardens and considering that impervious area would contribute 100%, computations were effected and the results indicated that there would be a huge 25% increase in water received at the drainages. The increases of 50% of balance area for residential buildings and 100% for commercial buildings are considered possible due to the reason that the size of plots are very small in the Colombo City and also after several field observations. In case of the 25% value, the managers need to realize that the change computed would not be evenly spread over the ward but would be concentrated with the topography which would eventually lead to significant flash floods. Therefore, detailed studies with the incorporation of topographic spatial data model would lead to identification of critical depression zones which can be provided with concentrated efforts by making rational resource allocations. For such details, an incorporation of topographic data on a GIS would enable suitable planning of roads, land cover changes etc..

The land information GIS systems are extremely useful applications for building development and planning, behaviour of zones and the trends, drainage planning, road condition planning. Potential of GIS has already been shown in the area of collection of taxes and provision of services. Real estate developers would be able to identify and develop land to serve the public better with suitable access to services and provision of facilities. These are some of the potential area of possessing an accurate urban land management system.

7.0 Conclusions

1.0 The Case Study of the Thimbirigasyaya Ward provided various examples that could be effectively used for the management of urban area thereby demonstrating the potential of GIS for urban land management.

2.0 GIS enables a manager to identify the spatial dimensions of management decisions taken with respect to tabular summarized data while it also enables a decision maker to visually analyze and carryout tabular verifications, thereby exponentially increasing the effectiveness of decision making.

3.0 Thimbirigasyaya ward has indicated potential to rationally manage the land plots within the available legislation while keeping to the targets of the zoning planners. A GIS would elevate real estate management of Thimbirigasyaya to a new dimension which will serve the stakeholders in a better manner.

4.0 The present dataset without the land surface

and topographic information enabled to assess the load on the drainage system due to various landcover types. This showed as a significant increase even with small increase of paved area. Therefore the study enables the managers to identify flooding potential due to various developments.

5.0 The Database contains gaps in data, careful and secure updating of shape information with the use of precision surveying, satellite imagery etc., and updating of attribute data could lead to immense benefits with regards to land planning and management.

6.0 Additional physical data such as Soil, Topography, Groundwater, and also services data such as availability of security, water supply etc., would provide other options in the area of land management in urban area

8.0 Acknowledgement

The present work was carried out as a continuation of the first author's work for his Master of Science Degree from the Deparment of Civil Engineering, University of Moratuwa. The support given by the Urban Development Authority and the International Center for Geoinformatics Applications & Training (ICGAT) and its staff is gratefully acknowledged.

9.0 References

Albert K.W. Yeung, Concepts and techniques of Geographic Information Systems, Indian reprint ed, Ontario Police college, Aylmer, Ontario, Canada, 2005.

City 2008 City Population web information, Principal Municipal and Urban Councils data Table, Colombo, http://www.citypopulation.de/SriLanka.html, visited 15th July 2008

Gazette 1999 Gazette Extraordinary 1090/13 of 29.07.1999, The Gazette of the Democratic Socialist Republic of Sri Lanka, Sri Lanka Government Printing Department, Colombo, 1999

Kapruka (2008), Kapruka Information Web Site, Real Estate Value Trend - Colombo and Suburbs, http://www.lanka.info/Sri_Lanka/realestate/propertyValuesReport.jsp, Visited 14th July 2008.

Leelananda H.H., Wijesekera N.T.S., Peiris T.A., (2005) A System for Land Development Approval Management Using Geographic Information Systems - A Case Study of Thimbirigasyaya Ward, Colombo, Engineer Journal of the Institution of Engineers, Sri Lanka, October 2005

Mehta, Ragupathi, and Sharma (1996)

Dinesh B. Mehta., Usha P. Ragupathi, and Rajesh Sharma, Environmental Mapping for Integrated Urban Infrastructure Development, Intergrated Urban Infrastructure Development in Asia, Kulwant Singh, Florian Steinberg, and Nathaniel von Einsiedel Editors, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi, 1996

Mendis (1998) Mendis Willie, Improving Urban Land Management in Sri Lanka, Urban Land Management; Improving Policies and Practices in Developing Countries of Asia, Jamal H. Ansari and Nathaniel von Einsiedel., Editors, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi, 1998

Ming and Hin 2006 Yu Shi Ming and Ho Kim Hin, Planned Urban industrialization and its effect on Urban Industrial Real Estate Valuation: The Singapore Experience, Habitat International 30, 509-539, Elsevier, 2006

UDA 1999 Urban Development Authority, City of Colombo Development Plan 1999 (Volume I and II), Ministry of Urban Development, Housing and Construction, Sethsiripaya, Battaramulla, Sri Lanka, 1999

Ulu, Aksoylu and Cabuk (2005) Ulu, Ali, Aksoylu, Sevin, and Cabuk, Alpher, GIS for

Urban Conservation, GIM International, Reed Business - Geo, The Netherlands, April 2005